

The background of the slide features a large, stylized image of Saturn with its rings, and the Cassini spacecraft is visible in the lower right corner, appearing to orbit the planet.

***Cassini* Free Market Resource Allocation**

Dennis Matson

Senior Research Scientist, and
Formerly Project Scientist
NASA/ESA Cassini/Huygens Mission
Presently Study Scientist, Titan Orbiter and Saturn System Mission
Jet Propulsion Laboratory, California Institute of Technology

PI-Team Masters Forum
The NASA Academy of Program/Project and Engineering Leadership
August 4-7, 2008, Annapolis, Maryland

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How the Cassini Payload Reserves were Managed

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The Challenge

- Optimize the use of payload resources
- Apply the best expertise in reallocating payload reserves
- Try to minimize the management overhead (consistent with above)

Cassini/Huygens Payload Situation

- 18 instruments, most with cutting-edge technologies
- Needed “expert” advice for using reserves
- In several cases all of the world’s “experts” were associated with the payload
- Needed a process for using their expertise
- The answer for this and other problems

Prelude to Trading

- Payload
 - 18 instruments (Principle Investigators)
 - Negotiate delivery contracts with PI's
 - Hold “expert” review to verify that deliveries should be possible
- Distribute all payload margin (about 15%) to the PI's
 - \$ by FY
 - Mass (in kg)
 - Power (in Watts)
 - Data rate to spacecraft bus (in kbs)
- Provide a method for the PI's to trade resources
 - Define well !
 - Establish rules !
 - **Open the market!** (All offers and trades reported electronically.)
 - Project Manager, Project Scientist, and the Payload Manager had veto authority

Comparison of "Traditional" vs. Market Approaches

- Margin vesting
- Who changes the instrument resources profiles?
- Visibility of resource usage
- Margin optimization
- Who will fly?
- Trading complexity
- Overhead
- Team building
- Lessons learned

Margin Vesting

Payload Manager

- **Margin or reserve is vested in the Payload Manager (“payload reserve account”)**

Resources Exchange

- **Each PI is vested with the reserve for his instrument**
- Gives the PI control over his/her fate

Who Changes Resource Profiles?

Payload Manager

- **Payload Manager**
- Manager does not have detailed knowledge of the situation and necessary expertise
- Every margin allocation by a manager is a win-lose transaction. The receiver wins and everyone else loses due to less margin being available.
- “Early bird gets the worm.” Those who declare an early bankruptcy have the advantage. Those who try to get by with what they have are at a disadvantage. When they need help, the margin has all been allocated.
- “NASA Board said my instrument more important!” Take what I need from someone else.

Resources Exchange

- **Instrument PI's via the commodities exchange**
- Decision made by PI's and teams best qualified to evaluate complexity, risk, and need

Visibility of Resource Usage

Payload Manager

- **Manager is expected to maintain a predefined margin profile.**
- Manager under pressure to increase his margin, if too low for the present stage of development. Only option is to cancel an instrument.
- PI's are hiding anything not used in order to prevent seizure by the manager. This undermines an accurate assessment of the margin available.

Resources Exchange

- **No advantage to secrecy**
- **No required margin levels**
- **Knowledge of margin is continuously available**
- Openness has advantages. Others make helpful suggestions. Gifts can be given by a rich instrument in order to avoid a specific adverse impact.
- Promotes shared developments such as data reduction software through the recognition of common problems

Margin Optimization

Payload Manager

- **Depends upon the skill (and luck) of the manager.**
- Needs advice from external experts
- PI's try to hide anything not used in case they need it.

Resources Exchange

- **System tends to drive outcome in direction of optimum usage.**
- Strong motivation to trade excess mass and power. These commodities will soon have no value.
- Strong motivation to loan current year \$ not needed

Who will Fly?

Payload Manager

- **Management decides**
- When management feels that it must raise more margin it deletes instruments. Big lose-lose for everyone as the science advisory group is called upon to recommend which instrument to remove.

Resources Exchange

- **Flight guaranteed if instrument delivered on schedule and within budget** (*i.e., the PI meets his contract requirements*)
- This is a big morale booster because many teams know well in advance that they will fly.

Trading Complexity

Payload Manager

- **Single transactions**
- Payload Manager moves resources to and from his “payload reserve account”
- Transactions are against current holding in the “payload reserve account”

Resources Exchange

- **3 or 4 party transactions possible**
- Parties do not need to trade with each other. In 3 or 4 party trades you can give to and receive from different parties.
- We had a broker and software to help arrange multiparty exchanges

Overhead

Payload Manager

- Payload manager must prepare for each decision
- Unhappy parties may appeal to Project Scientist or Project Manager
- All parties prepare for each level of management “shoot out”.

Resources Exchange

- Decisions are made at the lowest possible level
- No appeal after a trade has been made.
- PI's are not compelled to trade and will only trade if they benefit from the transaction.

Team Building

Payload Manager

- Interactions have winners and losers.
- People hate each other. ☹️

Resources Exchange

- Transactions are win-win.
- Everyone happy. 😊
- Strong team building program requires win-win activities.

Lessons Learned

- Traded commodities and rules must be well defined. Uncertainty “kills” the system.
- Team building –through win-win interactions– paid off later when PI’s had to cooperate in using the spacecraft.
- Resource trading works very well (if set up properly). All 18 instruments flew to Saturn.

[Additional reading: Wessen RR, and D. Porter, A management approach for allocating instrument development resources, Space Policy **31** (3): 191-201 Aug 1997]